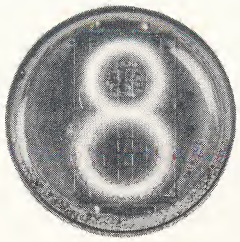
RAYTHEON

Datavue* Tubes

. . . a complete line of side-view and end-view indicator tubes

*Trademark of Raytheon Company



Datavue* Numerical Indicator Tubes

FEATURES

- **Low Cost**
- **Compact**
- **Uniform**
- **High Readability**
- **Low Power Drain**
- **Long Life**
- **Light Weight**
- **Rugged**
- **All-electronic Operation**
- **Bright Display**
- **Design Simplicity**

Raytheon Datavue Numerical Indicator Tubes are reliable, in-line visual digital readout tubes, which display singly the numerals 0 through 9 and preselected symbols such as + and − signs. Datavue tubes are gas-filled, cold-cathode tubes employing the familiar principle of the neon-glow lamp. The tubes are simply designed with a minimum number of components. The numeric tube consists of ten individual metallic cathodes formed in the shape of the numerals 0 to 9 and one common anode. The cathodes and anode are each connected to a base pin terminal.

Application of a d-c voltage between the anode and the selected cathode number causes the gas to ionize and glow around the metallic cathode providing a bright display of the desired numeral (over 200-foot lamberts output). Only the selected number is visible.

Datavue tubes provide high-readability characters in a pleasing and brilliant orange-red glow. They can be easily read in high-ambient light where other displays tend to wash out. Their $^{5}/_{8}$-inch high fully-formed characters have excellent readability: they can be read from thirty feet. Because they are fully-formed characters, erroneous readouts, due to a segment failure, do not occur.

Datavue tubes are available in end-view and side-view configurations. The side-view types cost less because their exclusive Raytheon engineered design provides manufacturing economies. Side-view types are also economical to install: a bezel and filter assembly can be eliminated, and the mating 11-pin sockets are less expensive than those for the end-view types.

The all-electronic design of the Datavue tubes offers both high-speed operation and low-power drain combined with high overall total-circuit reliability. The ultra-long life design tubes have a life expectancy of 200,000 hours or more in dynamic operation (display of different characters) and will often outlast the equipment in which they are used.

OVER FORTY YEARS OF GAS TUBE EXPERIENCE

Raytheon's leadership in producing gas-filled tubes has remained unchallenged since the mid-twenties with the development of the first cold-cathode full-wave rectifier, Type B (and later OZ4). Since then, Raytheon has produced more gas-filled tubes, ranging from subminiature thyratrons to high-voltage trigger tubes, than the rest of the U.S. tube industry combined!

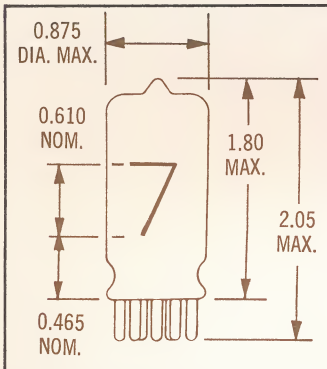
Raytheon Datavue tubes utilize Raytheon's sophisticated know-how in such significant areas as: value-engineered designs, metallurgy, cleaning and processing of parts, welding and assembly techniques, glass technology, exhaust processing (including both vacuum and gas technology), quality control and life testing. The basic design and carefully controlled manufacturing processes assure from each tube a controlled electrical performance and uniform brilliance throughout life.

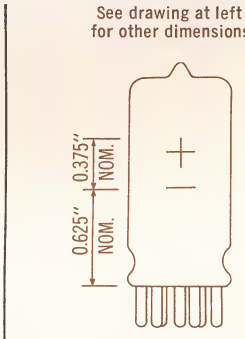
*Trademark of Raytheon Company

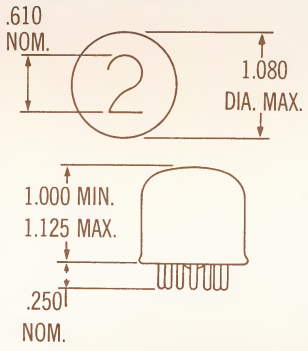
Technical Data

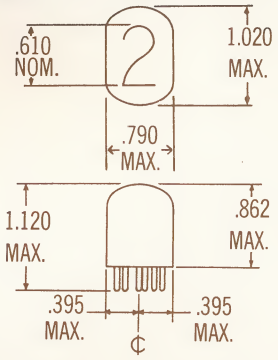
ELECTRICAL DATA	Ultra-Long Life* †CK8037/ 5031	CK8650	CK1900	CK8421/ 5092	CK8422/ 5991	Regular Life †CK6844A	
ABSOLUTE RATINGS:							
Minimum d-c supply voltage	170	170	170	170	170	170	volts
Maximum d-c ionization voltage	170	170	170	170	170	170	volts
Maximum peak cathode current	3.5	3.5	3.5	3.5	3.5	4.0	ma.
Maximum d-c cathode current	3.0	3.0	3.0	3.0	3.0	4.0	ma.
Minimum d-c cathode current	1.5	1.5	1.5	1.5	1.5	1.5	ma.
Minimum d-c prebias voltage	50	50	50	50	50	50	volts
Maximum d-c prebias voltage	120	120	120	120	120	120	volts
TEST CONDITIONS (FIG. 1)							
Supply voltage	170	170	170	170	170	170	dc volts
Anode series resistor (±1%)	10.0K	10.0K	10.0K	10.0K	8.2K	15.0K	ohms
Minimum cathode current	1.5	1.5	1.5	1.5	1.5	1.5	ma.
Maximum cathode current	3.0	3.0	3.0	3.0	3.0	3.0	ma.
RECOMMENDED OPERATING CONDITIONS (FIG. 1)							
Supply voltage#	200 250 300	200 250 300	200 250 300	200 250 300	200 250 300	200 250 300	
Anode series resistor	22K 47K 68K	22K 47K 68K	22K 47K 68K	22K 47K 68K	22K 47K 68K	27K 51K 75K	
MECHANICAL DATA							
Height of characters	0.61	0.61	—	0.61	0.61	0.61	in.
Weight	0.4	0.35	0.35	0.4	0.3	0.4	oz.
Outline	B	A-1	A-2	B	C	B	

NOTES:
*Only ultra-long life types recommended for pulse operation.
#Use of highest available supply voltage with appropriate anode resistor is recommended.
†These types are not recommended for new equipment designs.

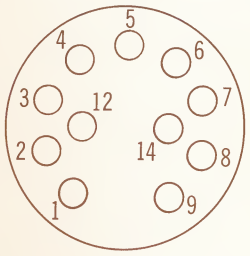






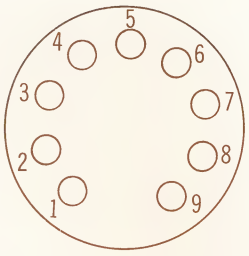


BOTTOM VIEW OF BASES



A-1

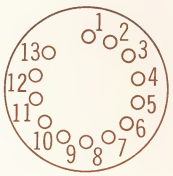
Pin No.	Numeral	Pin No.	Numeral
1	0	7	4
2	9	8	2
3	7	9	anode
4	6	12	8
5	1	14	3
6	5		



A-2

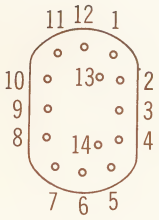
Pin No.	Character	Pin No.	Character
1	i.c.	6	i.c.
2	+	7	—
3	i.c.	8	i.c.
4	i.c.	9	anode
5	i.c.		

Standard EIA E-9-1 base.



B

Pin No.	Numeral	Pin No.	Numeral
1	i.c.	7	6
2	anode	8	i.c.
3	0	9	5
4	9	10	4
5	8	11	3
6	7	12	2
		13	1



C

Pin No.	Numeral	Pin No.	Numeral
1	anode	8	4
2	0	9	3
3	9	10	2
4	8	11	1
5	7	12	i.c.
6	6	13	i.c.
7	5	14	i.c.

i.c. = Internal connection — do not use.

See page 7 for designation of sockets

Electrical Considerations

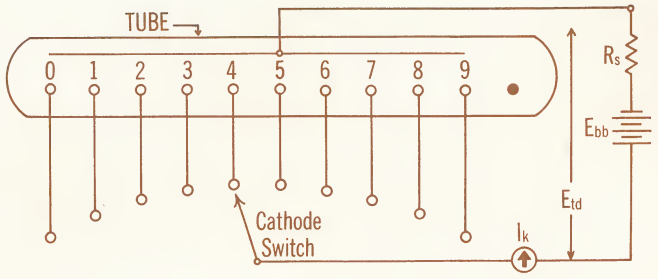


Figure 1. Simplified operating circuit for Datavue Indicator Tube.

THEORY OF OPERATION

A basic circuit showing how Datavue Indicator Tubes may be operated is shown in Figure 1. The tube operates similar to the gas-glow lamp. If a sufficiently high supply voltage (Ebb) is applied to the anode through a suitable current-limiting resistor, ionization will occur between the anode and the selected cathode. This will be evident by a distinctive orange-red glow outlining the particular numerical cathode selected. As the cathode switch is rotated through its ten positions, each numeral in turn will become visible through the window of the tube.

As with gas diode voltage regulators, the numerical indicator looks like an essentially constant voltage source as shown in Figure 2. Etd shown in Figure 1 represents this maintaining voltage drop between the anode and the particular cathode being used. Within the range of recommended cathode current, this tube drop remains relatively constant but with minor variations from cathode to cathode. Within the rated maximum cathode current the Etd may be several volts lower or higher than the ionization voltage. This characteristic requires the use of an anode series resistance (R_S) between the power supply (Ebb) and the tube terminal to limit the cathode current to the recommended range. For the convenience of the user, the values of R_S for several typical values of supply voltages are listed in the Technical Data.

OPERATING NOTES

Cathode Current: The readability of the Datavue Indicator depends upon the maintenance of the rated level of light output from its cathode. Light output is directly proportional to cathode current, and a minimum cathode current is necessary to assure complete glow coverage of the cathode numeral. On the other hand too high a cathode current can be detrimental to long tube life by causing excessive sputtering and consequent sublimation deposit on the glass envelope, decreasing its light transmission efficiency. The recommended minimum and maximum cathode current limits for these types — for example, 1.5 and 3.0 mAdc respectively for CK8650 — are designed to provide an optimum level of light output for ease of readability and at the same time to assure long life performance.

Supply Voltage: To assure ionization of all tubes, the minimum supply voltage should be no less than 170 Vdc, the maximum ionization potential rating for these types. However, a supply voltage as high as 300 Vdc is recommended. Together with a suitable current limiting resistor (R_S), a supply voltage higher than 170 Vdc will cause the circuit to approach constant current operation. With the value of R_S as determined by the equation (1), the spread of individual cathode currents will be smaller and the average value will be maintained near design center value. This, then, will assure a more uniform light output from individual cathodes as well as consistent operation over a wide temperature range and throughout life.

The value of R_S may be calculated from the formula:

$$R_S = \frac{Ebb - Etd}{Ik} \text{ ohms} \qquad (1)$$

Where Ebb = supply voltage
Etd = average anode to cathode voltage drop
Ik = bogie cathode current

For types CK8650 and CK1900 the average anode-to-cathode voltage drop for a bogie current of 2.25 mAdc is approximately 148 Vdc.

Cathode Pre-bias: For many slow-speed applications, mechanical or electromechanical switching of the cathodes, as shown in the simple circuit Figure 1, may give satisfactory performance. In this case, the cathode numerals not being read out are completely dis-

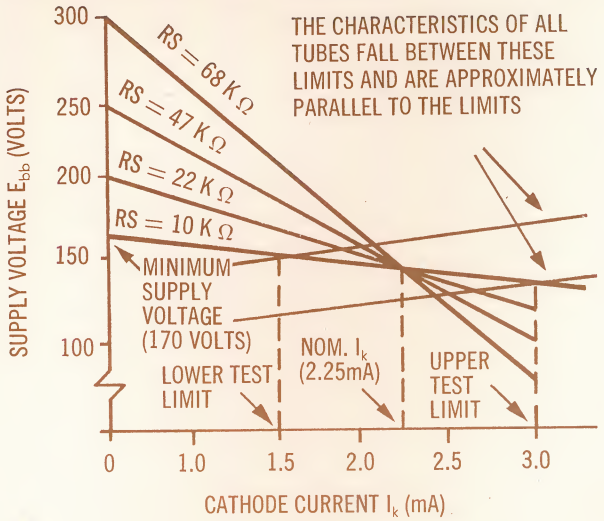


Figure 2. Electrical characteristics of CK8650

connected from ground and consequently draw no current. High-speed applications invariably require electronic driver switching circuitry. This circuitry may be simplified and its cost greatly reduced by operating the "off" cathodes at a positive bias potential above ground as shown in Figure 3. This will also permit increased speed of operation by reducing its dependency upon the ionization and de-ionization time of the gas within the envelope.

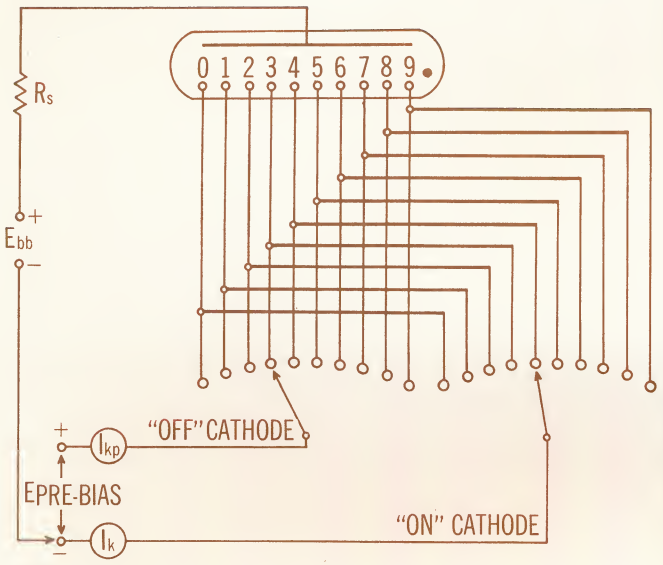


Figure 3. Basic cathode pre-bias circuit.

This mode of operation is similar to the "keep alive" operation of transmit-receive (T-R) tubes used in radar and communication equipment. The "off" cathodes are made to conduct a low value of current, thus preventing complete deionization during cathode switching. With the gas within the tube ionized by conduction between the anode and the "on" cathode (at or near ground potential), a very small current may be drawn by the "off" cathodes before an objectionable visible glow begins to appear on the "off" cathode numerals. This glow may be kept below the objectionable level by maintaining the minimum positive bias voltage of the "off" cathodes at a value greater than 50 Vdc above ground. On the other hand, the maximum positive cathode bias should also be limited. It should be kept well below the operating voltage drop, Etd. Otherwise the "off" cathode will approach the potential of the anode and will begin to assume the function of the anode. Its current will reverse and assume a high level since there is now no limiting resistance in the circuit. Under this condition, the tube may be damaged very quickly. The recommended safe range of positive cathode bias lies between these minimum and maximum values.

Figure 4 is a graph showing the value of "off" cathode current, per cathode, as a function of "off" cathode positive bias potential for the type CK8650. This characteristic for other types is similar. The area of objectionable cathode glow for the "off" cathode is shown to lie between positive bias values of zero

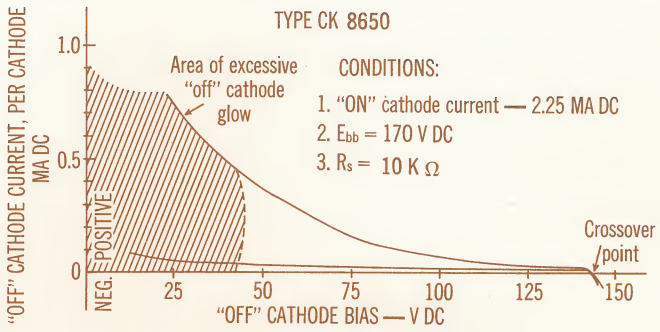


Figure 4. "off" cathode current (per cathode) characteristic.

and 50 Vdc. This is the area to be avoided to prevent confusion as to which cathode is "on". The upper limit of "off" cathode bias is the potential at which the cathode current reverses (cross-over point). A typical operating range of cathode bias for most types is between 60 and 80 Vdc.

It should be pointed out that the curves of Figure 4 show the range of "off" cathode current per cathode. These show the range of cathode bias over which satisfactory operation may be obtained. However, in an actual application at any given time, one cathode would be "on" and nine would be operated in a positive bias "off" condition. The total "off" cathode current should be added to the "on" cathode current to determine the total anode current. Keeping this in mind, it will be necessary to re-calculate the value of R_S to maintain the "on" cathode current of its recommended average value. With cathode bias operation, therefore, the following formula should be used to calculate R_S:

$$R_S = \frac{Ebb - Etd}{Ib} \text{ ohms} \qquad (2)$$

Where Ib = "on" + total "off" cathode current.

To facilitate the use of this formula, Figure 5 is a graph showing the spread in total "off" cathode current (9 cathodes) as a function of cathode bias for the type CK8650

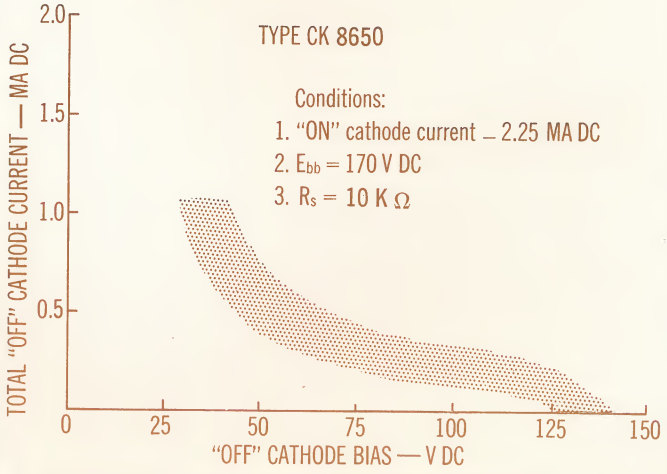


Figure 5. "off" cathode current (total) characteristic.

APPLICATION DATA

Raytheon Datavue Numerical Indicators are designed for decimally coded read-out applications such as basic counting and computing applications. Two well-known applications are digital voltmeters and digital time/frequency meters. By using suitable analog to digital converters or BCD to decimal decoders, other data may be converted and displayed in digital form.

Transistor Drivers: The driver for the numerical indicator must perform the function of an electronic switch. Transistors are excellent switching devices and are used in numerous applications to drive gas-filled, glow-discharge numerical indicators. Several manufacturers make transistors which are suitable for this application. Suggested Raytheon silicon types are 2N719 and 2N1990. Silicon control switches are an alternative device, having slower-switching speed.

As previously noted, the use of positive cathode bias on the "off" cathodes of the indicator tube permits simplified driver circuitry and reduced cost. With transistor drivers, the cathode bias of the "off" cathodes performs a dual purpose. It (a) operates the "off" cathodes with a small residual current thereby decreasing switching time and (b) serves as a collector voltage for the transistor driver. The use of cathode bias as a collector voltage for the transistor driver permits the use of a transistor with a lower collector voltage rating than otherwise required. This results in a saving in the cost of the driver transistors. Figure 6 shows a simplified circuit of a numerical indicator using one NPN transistor driver for each cathode. The transistors are operated in a back-biased collector-to-emitter voltage breakdown region (BVCEX). The inputs of the transistors may be driven singly in a time-sequenced arrangement for decimal-to-decimal indication or by a BCD to decimal decoder, depending on the application. Resistors R1 through R10 connected from each transistor collector to Ebb are used to assist adjustment of the cathode bias by modifying the BVCEX of transistors, where required, to eliminate objectional "off" cathode glow as described under the section on cathode bias.

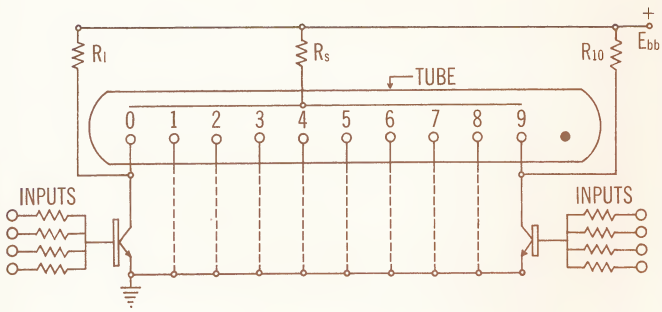


Figure 6. Transistor driver for Datavue tubes.

Photo-conductor Drivers: Photo-conductor devices (also called photo-resistors) have been used as electronic switches in some applications of numerical indicators. A photo-conductor cell connected in series with each cathode of the indicator is actuated by light emitted from a suitable lamp in the driver circuit. Such circuitry has the advantage of even greater simplification. The Raysistor, an optoelectronic device which has no moving parts and performs a variety of control functions, may be used to further simplify this kind of driver circuitry since it is a device containing both the light source and the photo-resistor. The electrical isolation between the driver and the indicator as afforded by this method of coupling may also be advantageous.

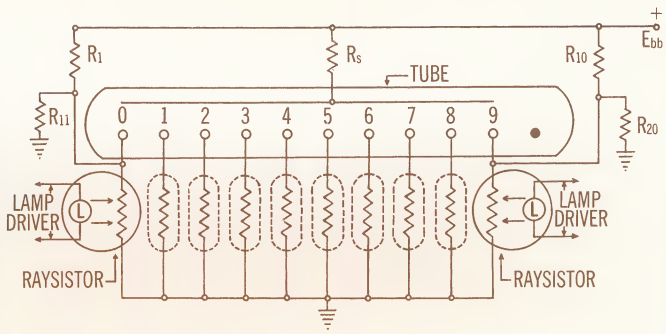


Figure 7. Driver for numerical indicator tubes using RAYSISTORS®.

Figure 7 shows a simplified Raysistor driver circuit using Type CK1124 or CK1101 P. The lamps can be driven directly by a vacuum-tube decade counter or a gas tube decade counter such as the CK6910. Resistors R1 through R20 in Figure 5 form voltage-divider circuits to operate the "off" cathodes of the numerical indicator tube at a suitable positive level. The "off" cathode voltage of the indicator tube must be considered in choosing a Raysistor since this voltage is also the signal voltage for the Raysistor.

Dimming: When Datavue Numerical Indicators are used in subdued ambient light their intensity can be smoothly controlled over a wide range. This is accomplished by circuits which turn the tube on and off by interrupting the anode or common-cathode return circuit at a repetition rate fast enough to prevent visible flicker. Adjustment of the duty cycle of the interruption will vary the brilliance. Variation of light intensity by adjustment of operating current of the tube merely by changing source voltage or anode series resistor is not recommended. Relatively dense filters may also be used to reduce light output, when viewing in darkened rooms.

SOCKETS FOR RAYTHEON INDICATOR TUBES

	Side View CK8650	Rectangular End View CK1903 (5992) CK8422	Round End View CK1901 (5016) CK1902 (50911) CK6844A CK8037 CK8421
COMMERCIAL GRADE			
Top of chassis mounting	CK1806	CK1818	
Bottom of chassis mounting	CK1808	CK1818	CK1822
Printed Board	CK1816	CK1820	CK1824
MIL GRADE			
Top of chassis mounting	CK1807	CK1819	
Bottom of chassis mounting	CK1809	CK1819	CK1823
Printed Board	CK1817	CK1821	CK1825
Mounting Position	Pin 5 to front	Pin 12 on top	Pin 8 on top

NOTE: Type CK1900 (+ and — symbols) uses standard 9-pin miniature socket. Side-view tubes with up to 8 characters have standard EIA E-9-1 9-pin base.

Mounting and Environment: It is desirable to mount Datavue Numerical Indicators in an enclosure which has been painted dull black on the inside to eliminate reflections from ambient light sources and the tubes themselves.

Contrast can be improved through the use of a red-amber filter or a polarized filter. This reduces the reflection from the glass envelope and the elements within the tube. Red-amber filters also reduce the bluish glow which is a characteristic of the ultra-long life tubes. Raytheon side-view indicators can be purchased with this filter film applied to the envelope.

ENVIRONMENTAL DESIGN DATA

1. Altitude	70,000 Ft.
2. Temperature (1)	—20°C to +55°C
(2) (Reduced life)	—65°C to +85°C
3. Acceleration	20 G's
4. Vibration (1) (in each axis)	10-50-10 cps at .08″ D.A., 5 min.
(2) (in each axis)	50-2000-50 cps at 10 G's, 5 min.
5. Shock (1)	50 G's, 11 millisec.
(2)	250 G's, 1 millisec.
6. Salt Spray	MIL Std. 202, Method 101 Cond. A
7. Humidity	MIL Std. 202, Method 103 Cond. B
8. Vibration Fatigue	MIL-E-1E, Method 1031
9. High Voltage Breakdown	MIL-E-1E, Method 1002
10. Life Expectancy (Dynamic)	
(1) Standard life	5000 hours
(2) Ultra-long life	200,000 hours

SPECIAL DATAVUE INDICATOR TUBES

Raytheon indicator tubes are available with special or custom-designed characters. Up to 12 characters can be obtained in one tube. Digits can be combined with letters, as well as symbols. Tubes with + (plus) and — (minus) signs are available as catalog items. For quotation and delivery, specify type number for the corresponding numerical tube and specify the special characters to be included.

Polarity Symbol Tubes

Type No.	Description	Use With Types Below*
CK1900	Side-View ±	CK8650
CK1901 (5016)	Round End-View ±	CK6844A
CK1902 (50911)	Round End-View ±	CK8037, CK8421
CK1903 (5992)	Rectangular End-View ±	CK8422

*See page 3 for data on these types

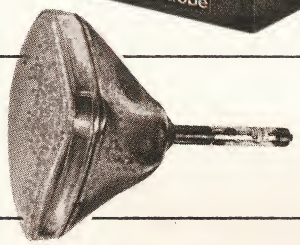
OTHER RAYTHEON DISPLAY DEVICES

DECADE COUNTER TUBES

Raytheon decade counter tubes are gas-filled cold-cathode, glow-discharge bi-directional stepping devices capable of operation at frequencies up to 100 kilocycles per second. They provide both electrical and visual readout.

DATASTROBE* DIGITAL READOUT SUBSYSTEM

Raytheon Datastrobe readout is a subsystem providing direct decoding and stroboscope display of 4 to 24 digits or characters projected on a screen. A single source of illumination is time-shared for up to six columns of display plus a floating decimal point. Similarly its time-shared logic accepts 4-bit-per-digit input at low signal level.



DATARAY* INDUSTRIAL CATHODE RAY TUBES

Raytheon manufactures a wide range of CRTs from 3 to 24 inch diameter including electrostatic, magnetic, and combination deflection types. All phosphors are available and specific design requirements can be met.

RECORDING STORAGE TUBES

Raytheon is the acknowledged leader in these electrical-input/electrical-output storage tubes. These high-resolution tubes are used in scan conversion and buffer storage systems. Standard size and miniature types are available.

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FOR DATA ON ANY OR ALL OF THESE DISPLAY DEVICES, PLEASE CONTACT YOUR NEAREST RAYTHEON REGIONAL COMMERCIAL OFFICE LISTED BELOW, OR WRITE COMPONENTS DIVISION, INDUSTRIAL COMPONENTS OPERATION, 465 CENTRE STREET, QUINCY, MASSACHUSETTS 02169.

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TWX: 213-778-0121

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San Carlos, California
(415) 593-1021

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RAYTHEON

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☐ DATARAY (industrial cathode–ray tubes) ☐ STORAGE TUBES

☐ DATAVUE (numerical indicators) ☐ PROJECTORAY (projection crt)

☐ SYMBOL RAY (character generators)

Name _____

Company _____ Title _____

Division _____

My exact mailing address is:
(This may be home address if all information requested above is supplied)

_____

_____ _____

DD2–67 Zip code must be shown